CONCRETE CONSTRUCTION P O BOX 444 ELMHURST ILLINOIS TERRACE 4 5110

FEB 1960

editor and publisher
WILLIAM M. AVERY

co-publisher
JOHN M. ENGLE

business manager
CLARISSA B. McKNIGHT

distribution manager
DOROTHY LUXFORD

ADVERTISING OFFICES

home office
P. O. Box 444—Elmhurst, Ill.
TErrace 4-5110

east coast
WALTER J. MASTERSON JR.
P. O. Box 206—Essex, Conn.
South 7-1838

west coast
Duncan A. Scott & Co.
1901 West 8th St.—Los Angeles
Dunkirk 8-4151

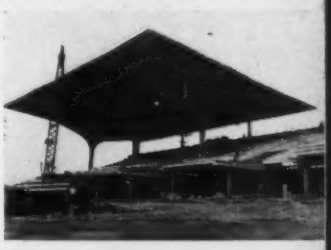
85 Post Street—San Francisco
Garfield 1-7950

Published monthly and copyrighted © 1960 by Concrete Construction Publications, Inc. Accepted as controlled circulation publication at Chicago, Illinois. Individual subscriptions at the rate of $5.00 per year, $9.00 for 2 years (U.S.A.); $10.00 per year (foreign). Single copies $1.00. Bound volumes of previous years' issues, when available, at $10.00 (U.S.A.), $15.00 (foreign). Subscription and bound volume orders must be accompanied by check or money order.

COMING NEXT MONTH

What Is Concrete? A down-to-earth discussion of some of the things we know, some of those we suspect, and some we just plain don't know at all, about a complex but wonderfully versatile material.

Placing Reinforcing Bars. Readers can test their reinforcing know-how by checking the answers to these basic questions concerning reinforcing theory and practice.



Largest Inverted Umbrella Roof. Giant hyperbolic paraboloids help lure spectators to a new race track while providing economical shelter over the grandstand.

Casting Concrete Pipe in Place. Using inflatable rubber and fabric forms, a newly developed machine casts 8 to 12 feet of concrete pipe per minute in a freshly dug trench.

Over 33,000 copies mailed. Edited for all who are concerned with quality, job placed concrete (including prestress, tilt-up, lift slab, and thin-shell)—its specification, production, handling, forming, reinforcing, placing, finishing, and curing: *Concrete Contractors, General Contractors, Engineers, Architects, Industrial Construction and Maintenance Men, Highway Engineers, Ready-Mixed and Prestressed Concrete Producers.*

About our page numbers: The pages of Concrete Construction Magazine are numbered continuously from January through December each year as a means of facilitating the use of bound volumes for reference purposes.

THE PERFORMANCE OF WATERSTOPS is to a great degree dependent upon the care and skill with which they are installed, and it is the purpose of this article to discuss some of the basic procedures which field experience indicates will assure best results. In the discussion that follows it is necessarily assumed that the joints have been properly designed, located and formed, and the procedures which are discussed relate wholly to the handling and installation of waterstops.

First off, analyze the joint across which the waterstop is to be installed. The type (contraction, isolation, expansion, etc.) as well as the spacing of the joint will have a great bearing on the amount of movement to be expected and, therefore, the waterstop to be used. Choose the shape and size of waterstop that is best suited to the job at hand. (See *Waterstops in Review,* Concrete Construction, December 1959, page 5.)

INSTALLATION OF WATERSTOPS

Some job site practices which will help assure maximum effectiveness.

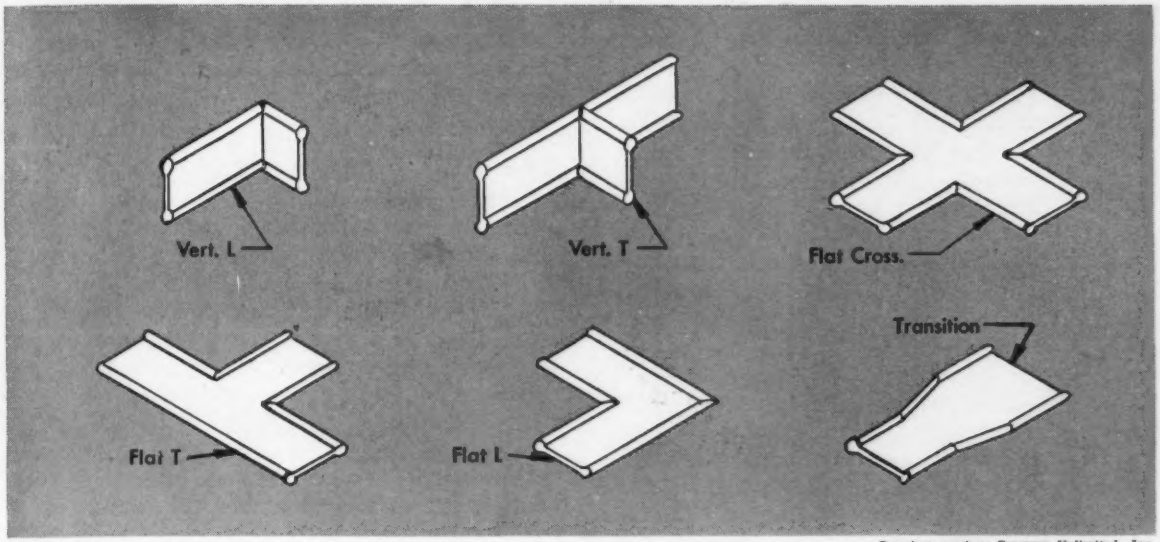
There are so many varieties of waterstops on the market today that it would be impractical to try to present detailed installation instructions for each of the many variations. We will, however, give a few suggestions that apply to most waterstops. The various manufacturers are prepared to supply details based on wide experience with their own particular types.

splices

A crucially important aspect of waterstop installation is the care with which splices are made. Most flexible waterstops are available in 50- to 125-foot rolls; this means that for many structures in which waterstops are used there will be a considerable number of splices. If these splices are made haphazardly, water leakage is sure to be objectionably great.

There are a number of jointing patterns commonly used in waterstop work, and some manufacturers provide a range of fittings to facilitate handling in the field. The waterstop must be cut neatly and to a true angle if an effective splice is to be made. Be sure the knife used for cutting is sharp.

For polyvinylchloride materials, heat to 450 degrees F. a ¼-inch steel plate on a plumber's torch (see picture series). Apply the two cut edges of the waterstop to the plate until melting of the plastic commences. This will take from 15 to 50 seconds, depending on the thickness and composition of the material. Hold the two edges together until they have cooled completely and



Drawing courtesy Progress Unlimited, Inc.

These drawings show how flat or keyed watertight joints are made using waterstops in combination with split forms.

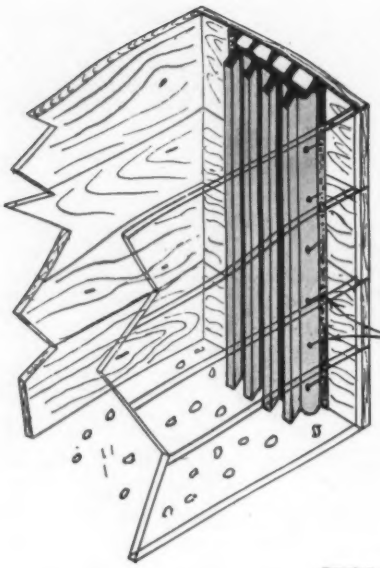
Heating the ends of diaphram-type waterstops in preparation for butt splicing. The splice is completed by holding the ends together until they form a bond.

Photo courtesy W. R. Meadows, Inc.

fused together. If a splice is to be made with one section of the waterstop already installed in a slab, the hot steel plate can be held against the waterstop. While the plastics are probably the easiest of the waterstop materials to splice, the tensile strength (resistance to stretching forces) at splices will usually be only 60 to 70 percent of that of the unspliced sections.

Rubber waterstops can be cold lap spliced. In this technique, the ends of the waterstop are overlapped about three inches with flat surfaces pressed togther. Coatings of rubber cement and uncured gum rubber are placed on the surfaces in contact at the splice and are held together by bolting between flat stainless steel plates. Cold lap splices are relatively easy to make and do not require any electricity; but the tensile strength provided at the joint is low. A considerably stronger splice can be made by vulcanizing. For this type of splice, small portable vulcanizers are used which commonly are electrically heated. The edges to be butted are beveled to 45 degrees or flatter. Rubber cement and uncured gum rubber are then applied to the ends and vulcanized, usually at around 290 degrees F.

Metal waterstops are spliced by means of welding. Although this produces a very watertight splice, it necessitates special equipment, electricity, skilled workmen and much time—especially when part of the metal waterstop is embedded in concrete. In addition, metal waterstops require more splices because they cannot be conveniently handled in long sections.

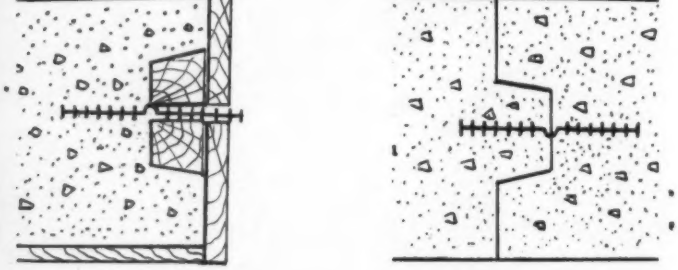


Drawing courtesy Walter Seals, Inc.

The drawing above shows a labyrinth-type waterstop nailed to wood forms in preparation for forming a watertight vertical joint in a wall.

Some of the special waterstop fittings which have been developed to speed up installation in the field.

Drawing courtesy Servicised Products Corp.



Since the integrity of the joints will depend to such a high degree upon the workmanship in making waterstop splices, especially careful supervision must be exercised over this aspect of installation.

other points

Before casting concrete, make sure that the waterstop material is clean. If it is covered with dirt and grime or if foreign materials have become lodged between the ribs (especially likely when the material has been protruding for some time from a cast section) it will be impossible to achieve intimate contact with the concrete. Without such contact, pull-out is a much greater likelihood.

Flexible waterstops should be braced against nearby rebars to render them better able to resist the disrupting effects of concrete placement. Thoroughly vibrate concrete near the waterstops to make sure that it is completely consolidated around all the configurations of the waterstop. Be certain that the center bulb, V-bend or other provision in the waterstop shape for joint movement is positioned directly at the joint opening.

Often a period of several days passes while concrete is curing and preparations are underway for the next placement. During this time the exposed half of the waterstop should be protected from damage by impact and thermal extremes.

After both portions of the concrete have been cast there remains still the application of the joint filler. There are a number of excellent preparations on the market today that provide both a high degree of water impermeability and great elasticity to accommodate joint movement. They protect the waterstop material from the adverse effects of the atmosphere (especially important when using rubber). Sufficient time should elapse after casting before application of the joint filler to allow the greater part of shrinkage caused by drying of the concrete to occur. The filler material will then be called upon to accommodate only the movements caused by loading and thermal variations.

Waterstops have come to play an important role in modern concrete construction. Their part in achieving watertight structures should not be underestimated. Through the constant research carried on by manufacturers and others interested in promoting quality construction, the waterstop has become an easily installed, inexpensive and durable device to insure watertight joints in walls, floors and decks. EN

Readers who would like to have additional information on the subject discussed in the foregoing article may request it by circling No. 242 on one of the reader service cards in this issue.

Factors Which Affect the Skid Resistance of Concrete

Concrete has excellent inherent skid resistant properties, but there are some variables in the picture which deserve consideration.

THE EXCELLENT AND UNIFORM SKID RESISTANCE of portland cement concrete has been an important factor in the strong preference for the use of this material in pavements of every type. Indeed, skid resistance has always been just another of the fine properties of concrete which everyone takes pretty much for granted. It becomes a matter of comment only in those fortunately rare instances when for some reason or another a concrete pavement surface does not provide the degree of skid resistance which we have learned to expect as a matter of course.

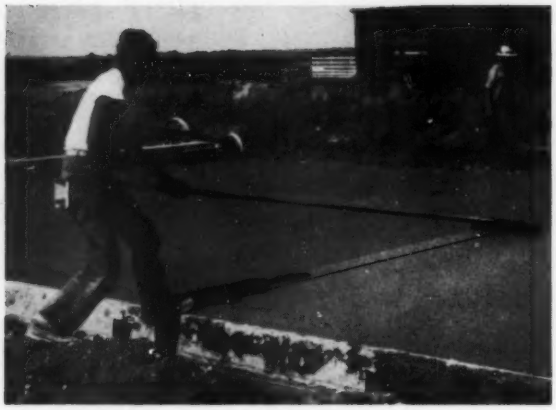
What are some of the factors which affect the skid resistance of pavements? A list of the more obvious ones would include the following: age and condition of the surface, type of aggregate and binder, the surface texture, climate and other factors which affect weathering, temperature, moisture, and the presence of foreign materials. It is a matter of common observation that the skid resistance of all pavements goes down when surfaces are wet. Perhaps less well known is the fact that skid hazard is almost always greatest during the first few minutes of rainfall following a dry spell. The driving lanes of multi-lane highways are generally more slippery than the passing lanes, partly due to the polishing effect of constant heavy traffic and partly due to a heavier accumulation of oil and other foreign materials.

There is no question at all that the surface texture built into concrete pavements is an important factor in skid resistance, especially when moisture is present. Water trapped between vehicle tires and any smoothly polished pavement surface becomes a highly effective lubricant capable of reducing the coefficient of friction to dangerously low levels. This danger can be considerably diminished by deliberately producing a textured surface having slight closely-spaced grooves and a finish not unlike that of sandpaper. Like the grooves in the tire itself, the grooves in the pavement provide a means for water to escape from between the two surfaces thus keeping them in the intimate contact which serves to reduce skidding. Fortunately the production of such textured finishes in concrete presents no difficulties at all.

One urgent requirement in producing a concrete surface which will have maximum skid resistance is to make certain that exposed surface mortar is kept to the minimum. Since it is usually excessive working which brings cement paste to the surface, this practice should always be avoided when maximum skid resistance is desired.

There are two generally accepted basic techniques for producing the type of textured surface which is most effective in the prevention of skidding. Both are carried out in the final finishing operations and they are about equally effective in respect to both skid resistance and wearing char-

Practically all pavements provide adequate skid resistance when dry. For adequate traction when wet, however, a pavement needs a course, gritty surface, such as the transverse grooved texture shown here.



Brooming pavement provides an excellent texture, it is not used extensively because of the cost.

A burlap drag is the most widely used method of providing a final finish texture. Here it is being applied manually.

acteristics. Brooming across the width of a slab produces a transverse grooved texture, and the use of a burlap drag, applied either manually or trailed behind a self-propelled bridge, produces a longitudinally grooved texture. The two techniques and the resulting surface textures are shown in the accompanying photographs.

Economics rather than any measurable superiority in results seems to have made the burlap drag technique a strong favorite among state highway departments. A survey conducted by the Portland Cement Association in 1958 showed that 23 states specify the burlap drag finish exclusively, that 11 others specify it along with the broom finish as an alternate, and that only 6 states specify the broom finish exclusively. Although once widely practiced, delayed belting with an open-textured belt is no longer recommended.

Aggregates have an obvious bearing on the skid resistance of pavements, and particularly on the effect of age and wear on skid resistance. In general a concrete made with an angular crushed aggregate will produce a more skid resistant pavement than one made with a rounded aggregate, but this superiority is bound to decline somewhat under the constant polishing action of heavy traffic. There are indications that sharply angular particles of coarse aggregate having tip angles of 90 degrees or less are superior in skid resistance to blunt particles having tip angles greater than 90 degrees.

The resistance of aggregates to wear is also an important consideration. In general it may be said that the harder, more wear-resistant aggregates retain excellent skid resistant characteristics longer than the softer aggregates. Limestones, especially those which consist largely of calcium carbonate, are not highly resistant to the polishing action of traffic. Especially in the case of oolitic limestones it may be desirable to improve long range skid resistance by the introduction of polish resistant materials as a replacement for fine aggregate. Partial replacement of fine aggregate seems to be considerably more effective than partial replacement of coarse aggregate. In one series of tests it was found that a 25 percent replacement of fine aggregate with crushed sandstone was somewhat more effective in improving skid resistance than a 50 per cent replacement with natural sand. The use of silica sand as fine aggregate is also quite effective in improving the skid resistant characteristics of limestone concrete.

Since any uniformly polished material will become slippery when it is wet, an important element in the production of a skid resistant pavement is to incorporate materials having different wearing characteristics. This probably means that limestones should not generally be used as total aggregate, but instead should be blended with some polish resistant fine aggregate material to improve skid resistance. This purpose can be accomplished even with a naturally rounded sand, although sandstones, silica sands and some varieties of granite are more effective.

There is growing evidence that the polishing of pavement aggregates is due largely to the fine abrasive particles which are found in tire treads and in road scum. The attrition of these materials produced by constant traffic movement sometimes causes coarse wear, and other times results in the fine wear associated with polishing and slickness.

Here are some other general procedures which will improve the skid resistance of concrete pavements: using more sand in the mix for the purpose of creating a thicker mortar surface than is customary; seeing that naturally rounded coarse aggregates are entirely crushed; vibrating antiskid aggregate into surfaces during construction.

ABOVE: A burlap drag is often trailed behind a self-propelled bridge, providing a longitudinally grooved texture.

BELOW: Close-up shows the surface left by the burlap drag. Note also the clean sawed joints.

The accompanying table, reproduced here with the permission of the Portland Cement Association, shows the astonishingly uniform skid resistance of concrete pavements of the various ages and finishes in half a dozen states. Under dry conditions the stopping distances in six states show a range of only 5.7 feet, notwithstanding the fact that ages range from 1 year to 24 years. Even wet pavement stopping shows a range of less than 16 feet. These figures are believed to be typical of the unique ability of most concrete to retain its initial skid resistance.

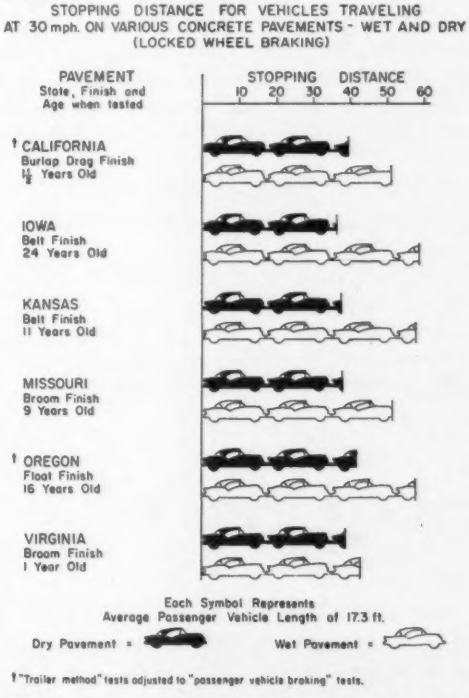
Although adequate statistics on the subject are surprisingly scarce, such evidence as has been accumulated indicates that skidding is by a wide margin the largest single cause of highway accidents. One study in Great Britain in 1957 showed that 27 percent of personal injury accidents on wet pavements and 82 percent on icy surfaces involve skidding as a primary factor. The problem of wet skidding in particular becomes more serious as speeds increase and traction coefficients decrease.

While the problem of skid prevention is now beginning to receive the serious attention it deserves, much needs to be done. Among the more urgent needs: a program of rating highways in regard to skid resistance; the development of a standard and reliable test method for determining the skid resistance of pavements; greater effort to assure the exclusion of surface materials which become dangerously slippery in service.

When excessive wear or other factors reduce the skid resistance of a concrete pavement below acceptable levels, resurfacing is always a possibility. There are several techniques for applying a thin surface of conventional concrete,[1] and a number of epoxy resin products[2] are also available. But there is actually little occasion to use such remedies for the simple reason that most concrete retains throughout its entire life the excellent anti-skid properties it exhibits when new. When experience indicates the possibility of difficulty, attention to the fundamentals discussed in this article should in all cases provide a generous margin of safety. END

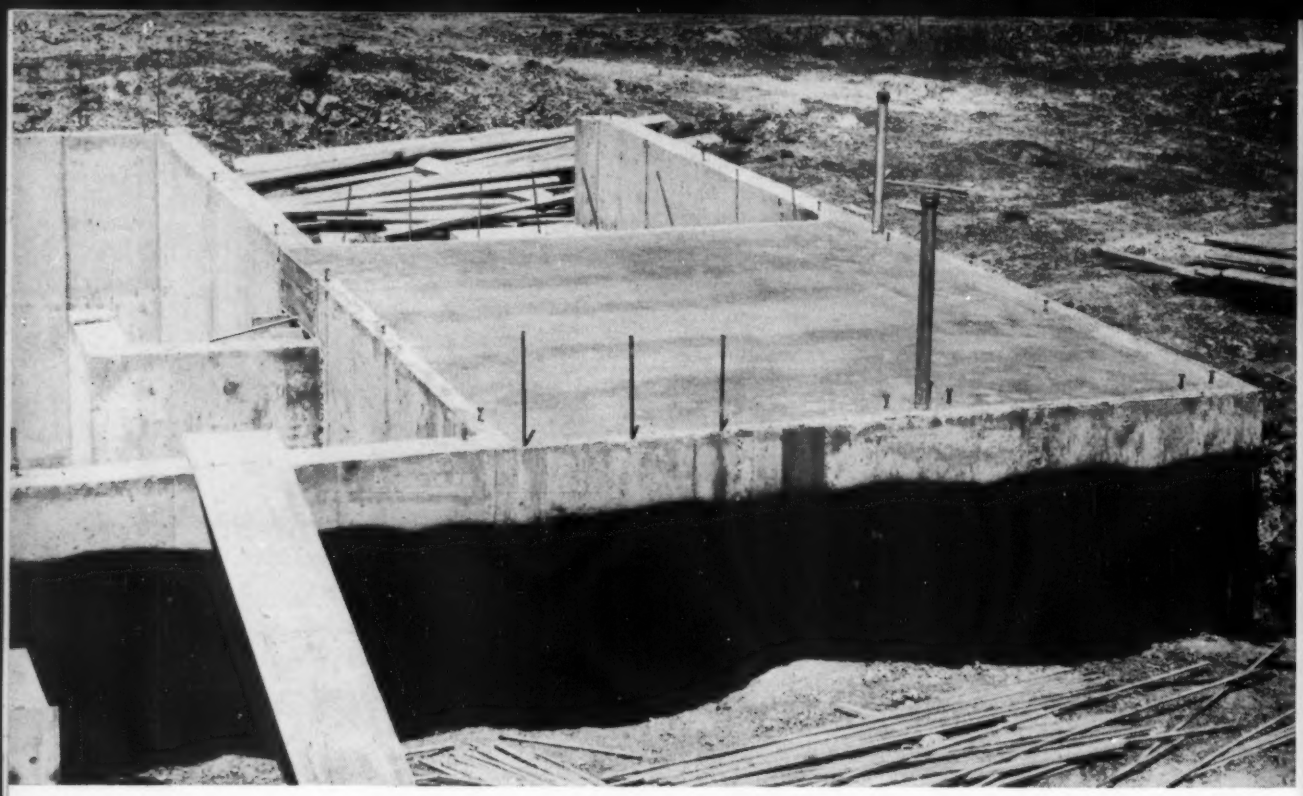
This graph shows the surprising skid resistance uniformity of concrete pavements regardless of the age, the geographical location or type of finish.

Graph courtesy Portland Cement Association.



1. See "Thin Bonded Resurfacing," Concrete Construction, July 1958, page 5.

2. See "Epoxy Alloys," Concrete Construction, January 1958, page 11.



View of the completed fall-out shelter. The shelter is located under the garage floor. The 12-inch concrete ceiling of the shelter forms one-half of this floor. As can be seen, three sides of the shelter are to be surrounded by earth since it is below grade level. That portion of the garage floor which is unfinished will be graded and concrete placed to form the remainder of the floor.

LOW-COST FALLOUT SHELTER

FILE: Basements

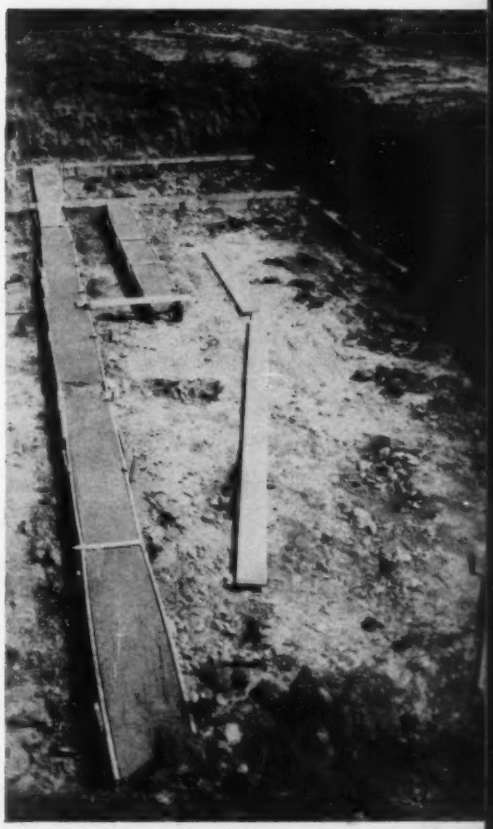
A COLORADO BUILDING CONTRACTOR has launched his own program for survival in the atomic age by incorporating low-cost reinforced concrete fallout shelters as integral elements in forty new homes under construction in a suburb of Denver. Cast as part of the foundation structure, the 12-inch concrete ceiling of the shelter forms about one-half of the garage floor in the model shown under construction in the accompanying pictures. Three of the homes were sold long before the model structure had been completed and in each case it is reported the shelter was a major factor in closing the sale.

The shelter's 8-inch vertical walls were constructed exactly as in any other house, and horizontal reinforcing bars were used in the shelter as they were in the basement walls. The doorway was formed in the standard fashion using normal steel reinforcing. An L-shaped wing wall was constructed to cover and protect the basement entrance to the shelter.

Tie-in reinforcing bars were placed every 16 inches around the perimeter of the shelter walls.

LEFT: Plywood panels used to form the basement walls were re-used for the shelter ceiling. Reinforcing bars for the ceiling were laid in horizontal positions to form 10-inch squares. One electrical outlet was provided in the center of the ceiling.

BELOW: View of the basement excavation. Approximately half of the area under the garage site has been excavated to accommodate the fallout shelter. Spread footings have been cast in the basement and shelter areas.



These vertical bars, located in the wall, extend approximately 30 inches above the walls and are bent to approximately touch the ceiling's horizontal reinforcing bars for the purpose of tying the ceiling and the wall together.

The inside shelter walls are pierced with two ¾-inch pipes connected to a water storage tank located inside the shelter. Two 2-inch ordinary plumbing pipes, used to conduct air for the filtered air system, are also imbedded in the concrete wall.

Plywood panels used to form the basement walls were reused to form the shelter ceiling. The ceiling forms were supported by 4- by 4-inch beams placed 16 inches apart. Reinforcing bars for the ceiling were laid in horizontal positions to form 10-inch squares. One electrical outlet was provided in the center of the ceiling.

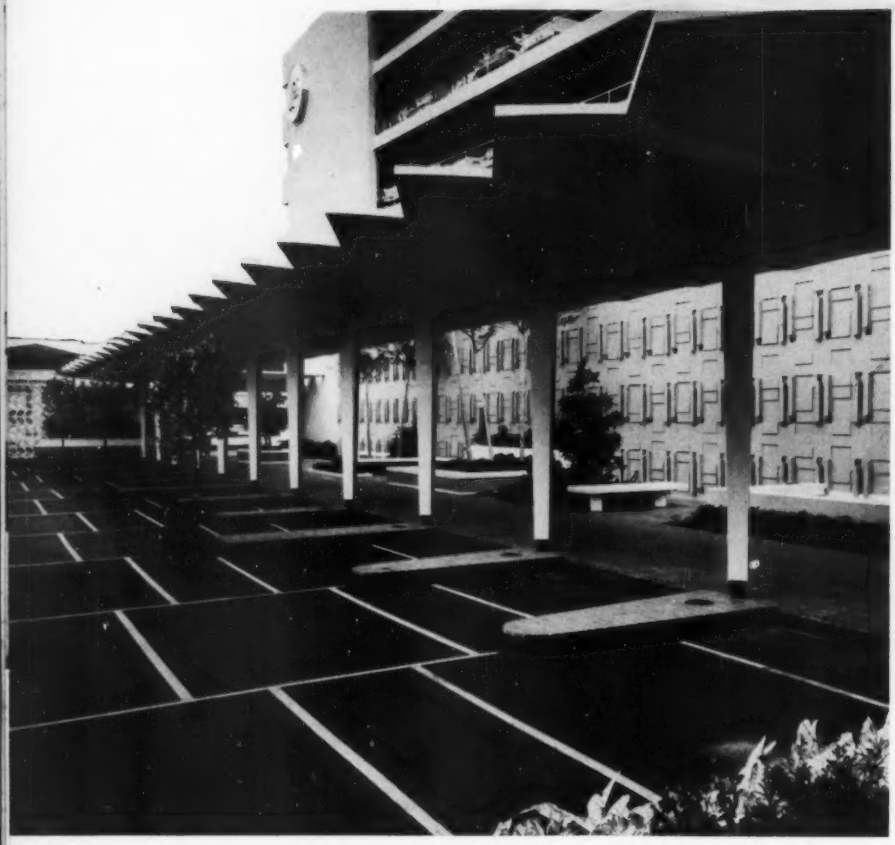
The ceiling slab of the shelter is also the floor slab of a portion of the garage. The second portion of the garage floor is laid on grade and tied to the first slab (previously placed as the shelter ceiling and garage floor), and is also tied to the shelter wall at this junction by vertical rods extending from the shelter wall and bent horizontally.

An estimate of the cost of this particular shelter is as follows:

Concrete	$120.00
Water tank	32.00
Steel	35.00
Miscellaneous	20.00
10 hours skilled labor	35.00
20 hours unskilled labor	50.00
TOTAL	$292.00

All steel for the shelter is prefabricated. While shoring lumber was custom cut for this first home, its reuse on the other 39 shelters to be constructed will allow depreciation of its cost.

The fallout shelter room is believed to appeal to home buyers because it readily lends itself to many every day uses. Some of the possibilities: photographic darkroom; laboratory (fireproof); workshop (easily made noise proof); playroom (also easily made noise proof); storm shelter; cool storage room. END



Shrubs and trees, against a background of black and white concrete, lend a park-like appearance to the downtown autobank.

Study in Black and White

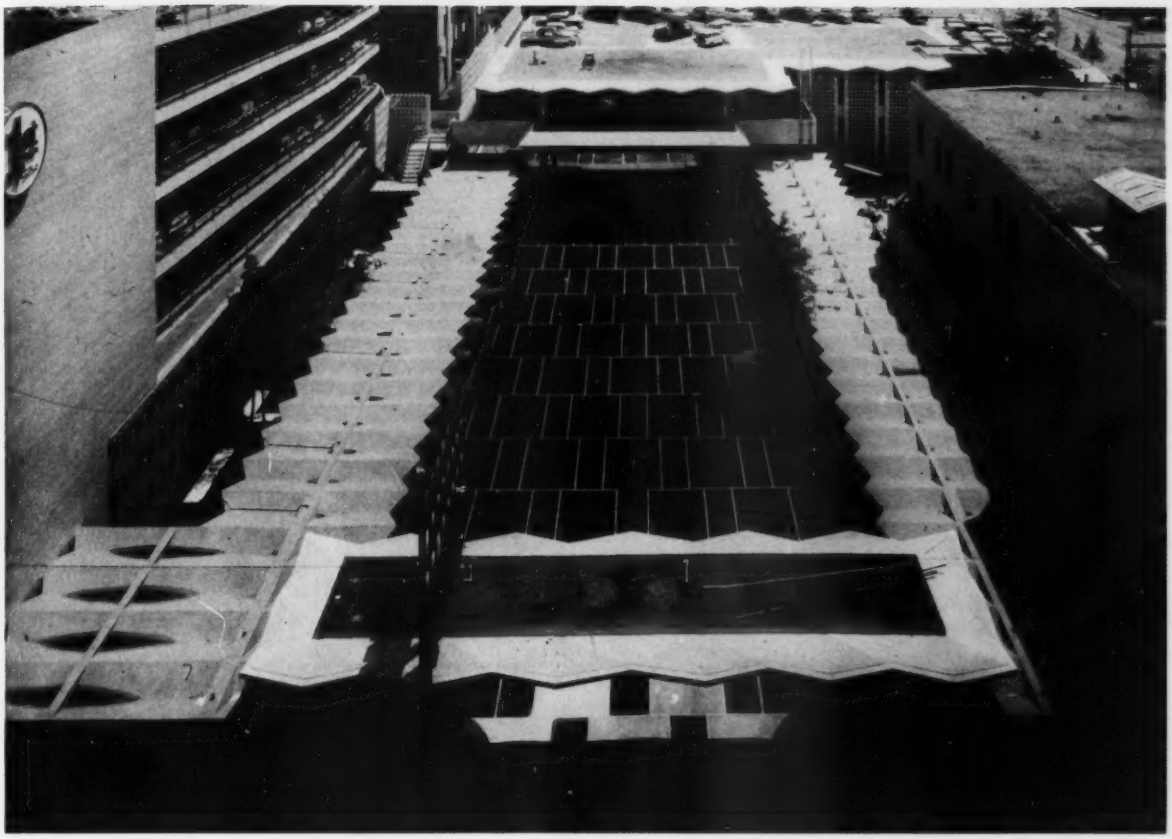
Used to be you could have any color you wanted in concrete as long as it was gray, but this is all changed now.

BLACK AND WHITE concrete driveways enhance the appearance of the new First National autobank in Tulsa, Oklahoma. The overall effect of driveways, along with white concrete canopies and white concrete second floor parkade, adds an eye-appealing structure to the downtown section.

The old axioms for any good concrete job hold twice true for a good color concrete job. To achieve uniform color a constant slump must be maintained and concrete must be finished at the proper time. That's the consensus of ready mix producers, contractor and finishers who worked on the job.

White concrete for the driveways was provided simply by using white cement and white sand in the mix. Use of limestone aggregate, which

FILE: Color



Black and white concrete in center section provides eye-appeal along with ground floor parking for Tulsa's new autobank. Concrete canopies, flanking parking area, cover walkways. Structure in background houses 2-story banking lobby and second floor parkade.

is plentiful in the Tulsa area, resulted in a whiter final product.

The black coloring compound used contained pigment, cement, high silica sand and a dispersing agent. Timing is most important and coloring was added after the concrete was screeded and floated, after the water had bled to the top and excess water had disappeared from the surface. Then the color was dusted on and floated into the top of the slab.

Variance in slump, causing more water in parts of the concrete than in others, will result in lack of uniformity of color. Also, dusting on the color before excess water disappears will cause a spotty color job. For the autobank project 4-inch slump concrete was used for both white and black concrete. Specifications called for 3000-psi concrete.

Because the driveways needed a relatively rough finish to give sufficient traction, the concrete was given a float, rather than trowel, finish. However, the coloring compound gives a denser surface than a plain mix float finish.

As soon as the surface became hard enough not to mar, workmen applied pigmented wax with a mohair roller. Only a thin coat was put on, as too thick a coat tends to be sticky.

Colored concrete accentuates float swirls and wax minimizes effect of the swirls. In addition to intensifying and making the color more uniform, the wax also contained a curing compound.

The black concrete was poured first. The wax coat was the only protection the black concrete had when the white concrete was placed. However, since driveways were poured 90 days before completion, there was some staining before the structure was completed. Just before the opening, workmen cleaned the concrete and applied another thin coat of black wax. END

Readers who would like to have additional information on the subject discussed in the foregoing article may request it by circling No. 243 on one of the reader service cards in this issue.

One method of studying the creep of concrete specimens under sustained load is shown in this picture taken at the Skokie Laboratory of the Portland Cement Association. The specimen at the left is being subjected to load by means of a hydraulic jack, while the creep of the one at the right is being checked with a Whittemore strain gage.

You'll probably hear lots more about creep in the years ahead. Here's a quick review of some current thinking.

Some Facts, Theories and Guesses Concerning Creep

WITH CONCRETE BEING USED for increasingly daring structures and with increasing dependence upon its own structural properties, there is today a much greater awareness than ever before of a phenomenon called creep. It is unhappily a characteristic of concrete (and some other materials, too) about which we don't know nearly as much as we should, but it will be our purpose here to tell what it is, to briefly discuss some of the theories concerning it, and to try to indicate some of the ways in which it can be kept within acceptable limits.

Creep is a desirable characteristic of reinforced concrete structures to the extent that it relieves concentrations of high stress by redistribution to adjacent areas. It may often be credited with saving structures which might otherwise have failed. Creep does not decrease the ultimate strength of a structural member—in fact, there is considerable laboratory evidence indicating that ultimate strength is often increased because of creep.

Concrete, in common with all known materials, deforms somewhat when it is subjected to a load. The visible sagging of a beam or slab, especially under conditions of extreme loading, is perhaps the simplest example. But whether they deform visibly or not, all structural members regardless of composition undergo some deformation if they support loads. The deformation which takes place immediately under load is called elastic deformation. This deformation would disappear at once if the load were immediately removed.

But there is another kind of deformation which takes place gradually under sustained load (such as the load of a structural member itself), and this type of deformation is what we mean when we speak of creep. It occurs even at very low stress levels, sometimes even as low as 1 percent of ultimate strength, and for a while it increases quite rapidly under sustained load. Fortunately the rate of deformation decreases with time, but there are indications that creep may continue for a very long time. In some instances increases have been noted after 25 years. Creep, moreover, under some conditions may greatly exceed the initial elastic strain.

Creep, then, may properly be regarded as a gradual yielding under load, as contrasted with the immediate yielding which we call elastic deformation. It should not be confused with another phenomenon called plastic flow which results from overstressing and is generally considered to be a type of incipient failure. Where creep is at least partly recoverable and occurs at very low stress, plastic flow is nonrecoverable and occurs only at very high stresses.

Other materials besides concrete are subject

to creep. Metals, timber and even some types of rock show much the same type of deformation under sustained loading as does concrete, but our knowledge concerning the mechanics of this phenomenon is so limited that we are not even sure that the same mechanism is always involved. Since structural deformations of every sort are for the most part undesirable,[1] every effort must be made within the limits of good economy to design and build structures which will not suffer either physically or esthetically from the inevitable changes which take place in the shape of materials under load.

This is why engineers, architects and builders are so interested in the problem of creep, and why it is so important to expand our knowledge on the subject. The elastic deformation which occurs in a beam under load can be calculated within very narrow limits of accuracy, and it is also possible to make design changes to reduce this deformation if the calculated value is excessive for the particular circumstances with which we are dealing. But since creep is a much more complex phenomenon spread over a virtually unlimited period of time, it presents serious difficulties for the designer.

In this discussion we will simply touch briefly on some of the theories[2] which have been developed to explain creep, and then go on to a somewhat more detailed discussion of the factors which appear to have a significant relationship to the problem.

Possibly the most acceptable of the several explanations of creep involves two separate approaches: the viscous flow theory, which embraces the notion that when concrete is under load the cement paste flows gradually (viscously) in transferring stress to the aggregate; and the seepage theory which endeavors to explain at least a part of creep as being due to the loss of water from the cement gel. The viscous flow theory seems to explain adequately the fact that the rate of creep reduces steadily with time. As stresses are transferred from the cement, which has marked ability to flow, and the aggregate which is relatively inert, it is reasonable to expect that the rate of creep would gradually decline (which it does) as equilibrium is approached.

No matter what theory is advanced in regard to creep, it seems certain that several causes are involved rather than just one. Some engineers have suggested that creep may also involve a crystalline flow similar to the plastic flow of metals. Others have advanced strictly mechanical deformation theories, and the only broad conclusion to be reached at present is that theoretical approaches in this whole area have been surprisingly barren of results.

Laboratory and field tests, on the contrary, have contributed a good deal to our understanding of some of the factors which influence creep, even though these empirical approaches have not answered many of the basic whys. Here, then, are some of the things we know about creep from actual observation rather than theory.

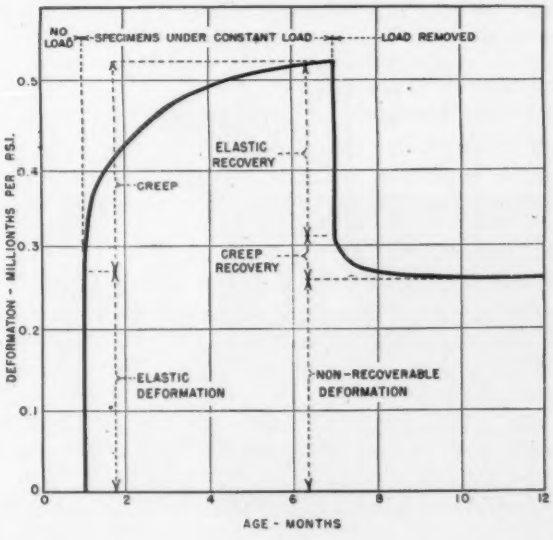
effect of materials

Creep characteristics are affected in some measure by the fineness and composition of portland cement, but fineness is probably not as important an influencing factor as composition. For normal portland cement tests indicate that creep will run higher for finely ground cement than for coarse cement, but this relationship is reversed for low-heat cement. There are also clear indications of an inverse relationship between creep and the strength of cement.

The creep of concrete varies inversely with the compressive strength. This is an important and well established fact, and is one of the principal reasons for the high quality of the concrete used in prestressing plants. Since strength increases with lower water/cement ratios, creep decreases with lower water/cement ratios.

Creep is measurably affected by the size, composition and grading of the aggregate in concrete. Concrete made with well graded aggregate having low void contents creeps less than concrete made

This graph shows the creep performance of a concrete specimen under a sustained load from the age of 1 month to the age of 6 months, when the load was removed. Note that the elastic and creep recoveries are less than the deformations under load because of the increased age of the concrete at the time it was unloaded. Graph reproduced from the sixth edition of the Concrete Manual, Bureau of Reclamation.



with poorly graded aggregate having high void contents. Creep also tends to decrease when the maximum size of coarse aggregate is increased, as well as when harder, denser aggregates are used. Other factors being the same, concrete made with limestone aggregate may be expected to show the least creep, with quartz, granite, basalt and sandstone following in that order.

Admixtures in general and air-entraining agents in particular do not appear to have any pronounced effect on the creep characteristics of concrete, but this is an area which might justify more careful study than it has so far received.

Slump appears to have a pronounced effect upon creep. One experimenter has shown that 2-inch slump hand-rodded concrete may creep 1½ to 2 times as much as zero-slump vibrated concrete having the same water/cement ratio. Creep also increases somewhat as the amount of cement paste increases.

effect of temperature and humidity

Concrete has less tendency to creep as cement hydration increases, so temperature and humidity conditions have a considerable bearing on the whole problem of creep. Water curing offers advantages over air curing, and both the rate and the magnitude of creep decrease when the humidity of the air increases. This is simply another way of saying that both the rate and ultimate magnitude of creep can be reduced by slowing down the rate at which the concrete dries. Tests also show that creep increases with increased temperature.

other factors

Large concrete members tend to creep less and at a lower rate than small members. Some observers believe that the creep of mass concrete may be only one-fourth that of small specimens even under ideal storage conditions. A factor which favors units of larger volume is obviously their slower drying rate.

Time is an important factor in any consideration of creep. While creep persists for many years under sustained loading, in concrete sections of average size from a half to three-fourths of the ultimate creep will usually take place in the first six months of sustained loading.

Within the range of ordinary working stresses creep tends to be roughly in proportion to sustained stress. At higher stresses the proportionality tends to break down, with creep increasing more rapidly in the higher ranges of stress. One of the striking characteristics of creep is that it apparently occurs at practically all stress levels, even as low as 1 percent of ultimate strength.

Creep in ordinary reinforced concrete beams can be reduced substantially by the inclusion of compressive reinforcing steel in the area in which the maximum bending moment occurs. Experimental work along this line indicates that compressive steel in an amount equal to tensile steel will reduce creep by as much as 50 percent.

One of the factors which is bringing greater attention to bear on the problem of creep is the rapid increase in the use of prestressed concrete. While creep may be serious enough in ordinary concrete, even if it only results in excessive deflections, in prestressed concrete excessive creep may actually bring about a dangerous reduction in the amount of prestress. Under extreme conditions the combined losses due to both creep and shrinkage may run as high as 50,000 psi, although the average loss is probably less than half this amount. It is believed that creep was largely responsible for the failure of early attempts to prestress concrete, and that the ultimate success of prestressing is attributable to the development of reinforcing strands which could be stressed high enough to retain adequate prestress even after losses due to shrinkage and creep.

Note that excessive creep does not decrease the ultimate strength of a prestressed beam, but simply allows greater deflection.

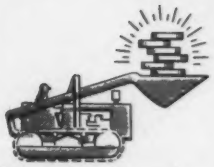
With the increasing use of lightweight aggregate concretes, attention has been directed to the performance of these materials from the standpoint of creep. While some lightweight aggregate concretes show less creep than sand-and-gravel concretes, especially at early ages, at ages of a year or more most lightweight concretes creep more than normal weight concretes, the difference in some cases amounting to around 25 percent. There are indications that some type of accelerated steam curing may bring about substantial reductions in creep of both lightweight and normal weight concretes.

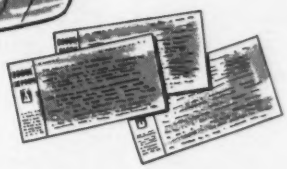
Many developments in the field of concrete construction today are imparting considerable urgency to the extension of knowledge into what were once considered areas of remote interest, and the matter of creep is just such an area. While there are many broad categories of construction in which creep does not appear to be a major factor, all serious technicians are in solid agreement on this one point: that we can never know too much about the properties and characteristics of concrete. Although for the moment the problem of creep rests mainly in the hands of the research worker, it is bound to be a matter of growing interest to the field man in the years ahead. END

---

1. Note, however, that there is a strong probability that creep helps bring about better stress distribution in some reinforced concrete structures.

2. Readers who would like a more detailed discussion of the subject should refer to "Theories of Creep in Concrete" by A. M. Neville, Vol. 52, Proceedings of the American Concrete Institute, pp. 47-60.

Want a bigger share  of the new construction contracts in your area?

Want to be sure you're not missing good bidding opportunities? Want a reliable way to size up jobs...to go after the ones that will do you most good ? You need daily Dodge Reports  ! !

DODGE REPORTS are individual building project reports. They're mailed to you daily. You get **REPORTS** on just the types of building you're interested in—in the area where you do business. They tell who's going to build what and where . . . whom to see . . . when bids are wanted . . . who else is bidding . . . who gets which awards.

When you use **DODGE REPORTS**, you always know what's coming up. You don't depend only on invitations to bid. You concentrate on jobs you *know* will be profitable.

If you do business anywhere in the 37 Eastern states, DODGE REPORTS are for *you.*

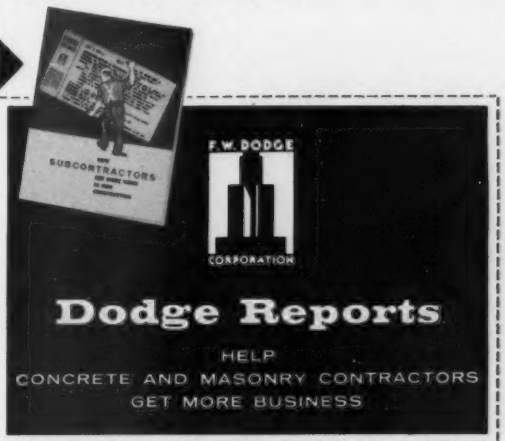
SEND FOR THIS FREE BOOK

F. W. Dodge Corporation, Construction News Division
119 West 40th Street, New York 18, N. Y., Dept. CC20

Send me the book: "How Subcontractors Get More Work in New Construction" and let me see some typical Dodge Reports for my area. I am interested in the general markets checked below.

☐ House Construction ☐ General Building
☐ Engineering Projects (Heavy Construction)

Area_____
Name_____
Company_____
Address_____
City_____ Zone_____ State_____

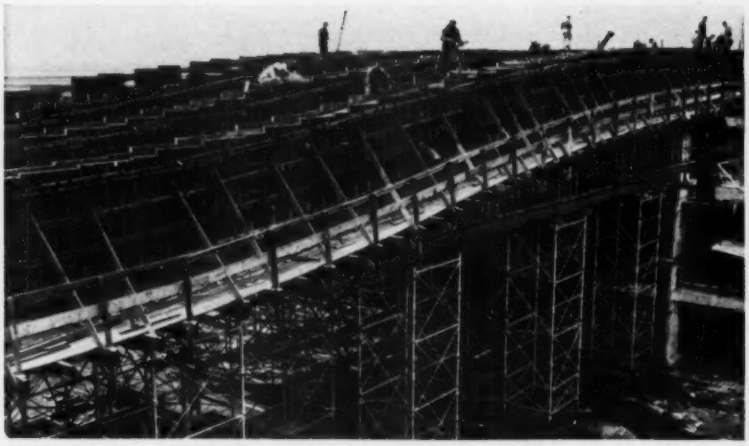


Circle 208 on reader service card

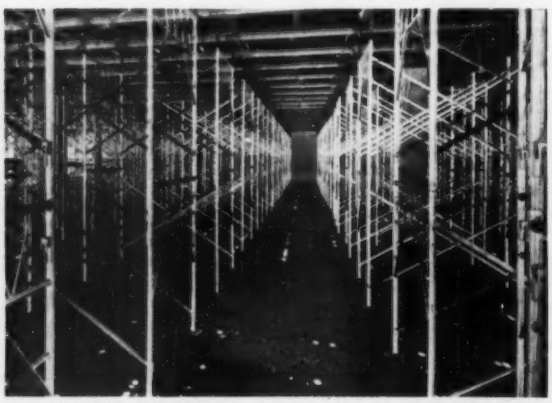
Shoring Methods

for concrete construction

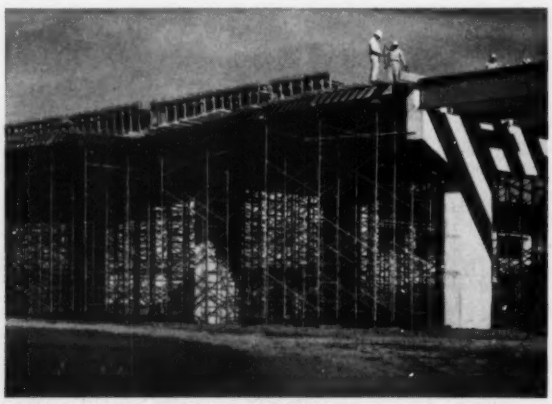
. . . by Patent Scaffolding CO.



EXTRA HEAVY DUTY SHORING Rolls to Pours—Mounted on a traveller, each Extra Heavy Duty Shoring set-up supports two of 16 clear-span concrete girders from 7′8″ to 8′8″ deep, 2′ to 2′10″ wide, and 125′ long, at Eastern Airlines Terminal Bldg., Idlewild Airport, N.Y. Gilbane Building Co., gen. contr., pours a pair of girders, lowers shoring and rolls it to new positions.



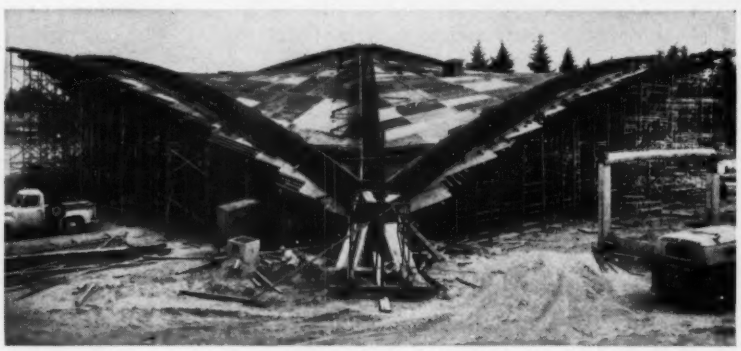
STANDARD SHORING Meets Most Job Needs—Standard "Trouble Saver" Shoring 5′-wide frames are assembled rapidly to provide safe, ample support for pan construction of the Atomics International Project, Canoga Park, Calif. Shoring supports 30″ x 30″ x 14″ domes with 4½″ slab. C. L. Peck Construction and Realty Co., general contractor.



NEW HEAVY DUTY SHORING Supports Bridge—Safe support for the heavy loads imposed by this concrete overpass in San Jose, Calif., is provided by new PS Co. 4′-wide Heavy Duty Shoring frames, tested under simulated field conditions to safely support loads up to 10,000 lbs. on each leg. General contractor, Oscar C. Holmes.

STANDARD FRAMES SHORE HYPERBOLIC PARABOLOID STRUCTURE—

On the new auditorium for Edward S. Ingraham H. S., Seattle, Sound Construction Co., general contractor, uses 1300 standard "Trouble Saver" Shoring frames to support dome and slab formwork for this concrete hyperbolic paraboloid structure. Design involves three anchors, set 161′ apart, from which three center beams, 2′6″ x 4″, arch to 35′ high. Two perimeter beams per anchor fan out and intersect at 28′ high.



THE PATENT SCAFFOLDING CO., Inc.

38-21 12th Street, Dept. CCM, Long Island City 1, New York

1550 Dayton St., Chicago 22 • Branches in all principal cities • 6931 Stanford Ave., Los Angeles 1

IN CANADA: CANADIAN PS CO., 329 DUFFERIN ST., TORONTO

Circle 213 on reader service card

Complete scaffolding equipment and engineering service offered through nation-wide sales offices or representatives. Look under Patent Scaffolding in the Yellow Pages for your nearest source.

SALES **RENTALS**

For letter-perfect concrete

These simple letters can be used to write volumes of praise for the men who use them in concrete construction. They can help compose an enduring testimonial for *your* work, too.

Reduce water with a few drops of WRDA and you instantly boost compressive strength as much as 25 per cent. By spreading the cement particles uniformly throughout the entire batch, WRDA gives you a more cohesive mix, yet one that places fast and clean. And with less water, there's less bleeding and segregation.

Add air and control it with DAREX AEA, and billions of bubbles lubricate the mix for smoother flow and finer finishing. Those same air bubbles effectively guard against frost damage and cracking, even in the toughest, coldest, wettest weather cycles.

These products cost so little, yet add so much, you owe it to yourself to try them both. You need both, WRDA and DAREX AEA, for letter-perfect concrete every time.

WRDA

DAREX AEA

W. R. GRACE & CO.
DEWEY AND ALMY CHEMICAL DIVISION

SEE US AT THE SHOW!

BOOTH 80

North Exposition Hall
Conrad Hilton Hotel, Chicago

NATIONAL READY MIXED CONCRETE ASSOCIATION
NRMCA

letters

yield problem

Sir:

On a certain project we are getting 3.7 percent air in ready mix trucks using specification sand and gravel. On road slabs with 34 E pavers and essentially the same materials we are getting only 1.7 percent to 2 percent air, resulting in a yield loss of about 1 percent. Every conceivable test has been made and no one seems to be able to come up with any answer. Why?

R. R. Ross
White Hall Cement Co.
Williamsport, Penna.

Concrete Construction would appreciate any suggestions from readers as to a possible solution to Mr. Ross' problem.
EDITOR

BRAB reports

Sir:

Permit us to express our gratification for the attention given, in the November 1959 issue, the Building Research Advisory Board Report No. 385 on Slab-on-Ground Construction.

To clarify the present status of reports on this subject, No. 385—the original report on this subject—has now been superseded by the following three studies, which are more exhaustive and which bring research more nearly up to date:

NAS 596—*Effectiveness of Concrete Admixtures in Controlling Transmission of Moisture Through Slabs-on-Ground*

NAS 657—*Design Criteria for Residential Slabs-on-Ground*

NAS 707—*Protection From Moisture for Slab-on-Ground Construction and Habitable Spaces Below Grade*

Thanks to your write-up, we are happy to report that considerable interest has been stirred, and a number of requests have reached us for No. 385, of which there are a few left-over copies still available. However, in the circumstances, we would appreciate your mentioning that the more recent reports referred to above are obtainable through the National Academy of Sciences—National Research Council Printing and Publishing Office in Washington, D. C.

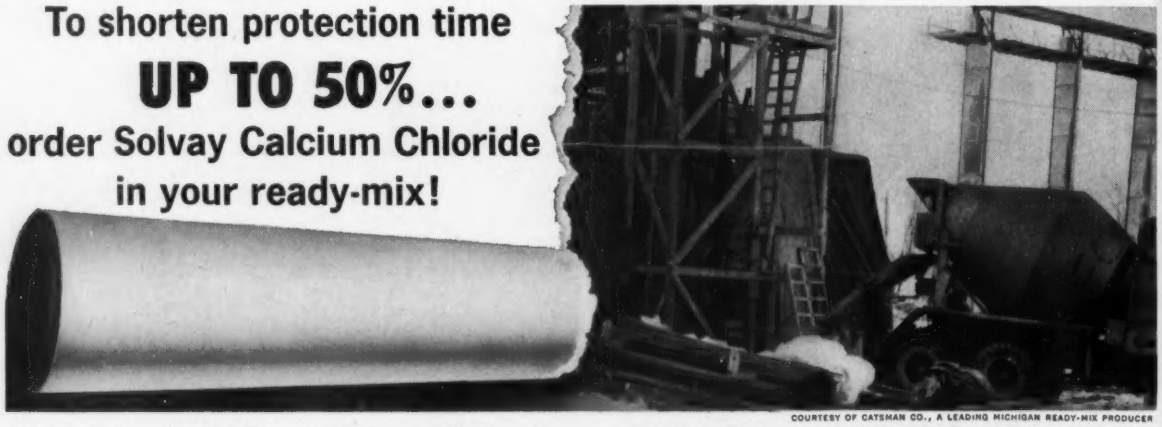
Again, our appreciation.

S. W. Lipsman
Building Research Advisory Board
Washington, D. C.

To shorten protection time

UP TO 50%...

order Solvay Calcium Chloride in your ready-mix!



COURTESY OF CATSMAN CO., A LEADING MICHIGAN READY-MIX PRODUCER

Your ready-mix supplier can help you keep your *winter* production close to *warm* weather working schedules. Order "Special-Winterized" mix, specifying 2% Solvay® Calcium Chloride*, heated water and aggregate.

You'll benefit these eight ways:

(1) Less overtime finishing–faster set. (2) Faster form removal–high early strength. (3) Savings in protection time–up to 50%. (4) Less delay between operations. (5) More safety through extra cold weather protection. (6) 8-to-12% greater ultimate strength. (7) Increased workability. (8) You use *less* water and you get denser concrete–more resistant to moisture and wear.

Write for Solvay's 38-p. "The Effects of Calcium Chloride on Portland Cement."

Allied Chemical

SOLVAY PROCESS DIVISION
61 Broadway, New York 6, N. Y.

SOLVAY branch offices and dealers are located in major centers from coast to coast.

*Speeds but does not change the basic action of portland cement. This use of calcium chloride is approved by Portland Cement Association, American Concrete Institute, Calcium Chloride Institute, leading highway departments.

Circle 201 on reader service card

SYMONS FORMS *can help your firm*

save on labor and material costs . . . save time . . . do a better job

Symons different type forms are not confined to a single type of application. They can be used on most any type construction job and on any height wall. Factory-made from the finest of materials. Frames of the Steel-Ply and Mag-Ply Forms have an indefinite life.

Wood-Ply

Symons manufactures three types of wood forms. *High Strength Panels* . . . recommended for pouring concrete walls with pressures up to 1,200 pounds per square foot; *"Champ"* Panels . . . for both commercial and residential work; *Light Construction Panels* . . . for light or residential construction, where heavy pressure is not a factor.

Symons High Strength Panel has steel cross members on 12" centers. Its weight averages just 5 pounds per square foot.

Wide Panel

Symons Wide Panel Forms have steel struts and 2x4 cross members to strengthen the panel and minimize deflection when subjected to heavy pressure. These forms are used in gang forming. They have tie holes in the steel struts which allow the insertion and removal of special ties when the panels are ganged. Built in 6′ and 8′ lengths and 30″, 36″, 42″ and 48″ widths.

Pouring a 2,400 foot retaining wall with Symons Wide Panel Forms made up in gang sections of 10′x24′ and 15′x24′.

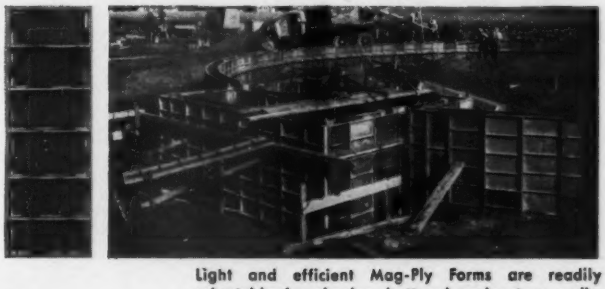
Steel-Ply

Designed for durability and long-life. The initial cost of these forms is higher than Symons Wood-Ply Forms. However, this first cost is more than offset by the many reuses possible with these panels. They are easily erected and stripped with the 3 basic pieces of the Symons System—connecting bolt, panel tie and wedge.

37,000 square feet of Steel-Ply Forms used on the Air Force Academy, Colorado Springs, Colorado.

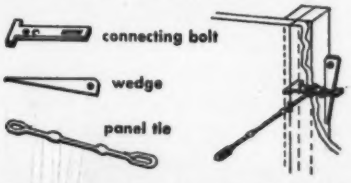
Mag-Ply

Symons Mag-Ply Forms are the lightest forms available . . . weight averages about 3½ pounds per square foot. The frames of durable, rust-proof magnesium completely encase the plywood, will last indefinitely and will not swell or shrink. 2½″ thickness of frames means more panels per truck load, less space for stacking and storage.



Light and efficient Mag-Ply Forms are readily adaptable for circular, battered and cut-up walls.

Only 3 Hardware Pieces



Symons Forms available on a Rental Basis. Rentals can apply to purchase price.

Symons CLAMP & MFG. CO.

4271 Diversey Avenue • Dept. B-0 • Chicago 39, Illinois

Warehouses in California, Kansas, Minnesota and New Jersey • Sales Offices and agents in principal cities

more SAVINGS from SYMONS

Circle 219 on reader service card

For Lowest Operating Costs and Minimum Investment

It pays in many ways to standardize on Viber Vibrators. Their amazing versatility – because they are mated – is one big reason why Viber Vibrators handle all your concrete vibrating jobs with the lowest possible investment and the least possible operating cost.

Check the many "mated" advantages below:

They're mated to permit interchangeability of components.

They're mated to give you 64 different vibrators – each with a special ability.

They're mated to make every component salvageable – only that part which is completely worn out is discarded.

They're mated to prevent any major component from becoming obsolete – old and new mate perfectly.

They're mated to reduce your spare parts requirements.

Assemble 64 Different Vibrators From 12 Basic Viber Units

Contractors who standardize on Viber Vibrators give their concrete crew a selection of three interchangeable power units—electric, pneumatic and gasoline... a selection of four interchangeable lengths of flexible drives... a choice of four interchangeable heads—1¾", 2¼", 2½" and 3"... and a multiple coupling for connecting any 2 lengths of shafts together.

Get the facts today! See your dealer or write for detailed information. Viber Company, 726 South Flower Street, Burbank 79, California

VIBER CO.

Pioneers and leaders in the manufacture of Vibrators.

It Pays to Standardize on

Viber Vibrators

Circle 223 on reader service card

books

Pavement Performance – Methods for Evaluation. Bulletin 187. *Published by Highway Research Board of the National Academy of Sciences — National Research Council, 2101 Constitution, Washington, D. C. Illus. $1.60.*

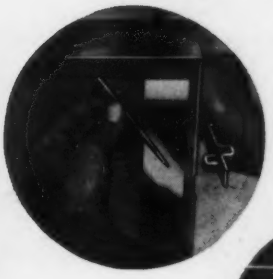
The several papers and discussions published in this bulletin were presented at the 37th annual meeting as a symposium. It was programmed to bring together everything significant that is known about identifying and explaining all kinds of defects and failures in paved highways.

"Types and Causes of Failure" gives charts outlining classification of failures for bituminous road surfaces and for portland cement concrete pavements. Thirty-six photographs are included as aids in describing various kinds and stages of pavement distress. The second paper deals with warning signs of distress in airport pavements as viewed by the U. S. Civil Aeronautics Administration. It tells of investigations that showed relationships of service behavior to the theoretical concepts in design of the pavements and to the results of accelerated traffic tests. Two authors, representing the U. S. Army Corps of Engineers, report on some rather historic investigations that included evaluation of rigid pavement performance and failure criteria for flexible pavements. A summary of what was learned about a 9-year-old concrete pavement by subjecting it to controlled full legal-load truck operations comprises another paper. Appropriate elements for rating a pavement are discussed in still another paper, and the last paper describes the methods, and some of the results, of a pavement performance inventory in Michigan.

simple
tie
installation...

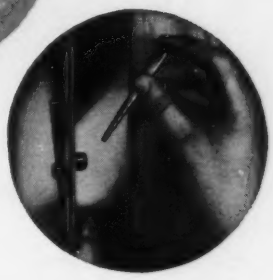
secret of FASTER CONCRETE FORMING

SECONDS
TO INSTALL
UNI-FORM TIE
AND ASSEMBLE PANELS



1. UNI-FORM Tie Loop placed in square tie hole of Panel.

2. Tie Key set into the Tie Loop. Panel and Tie are now locked together into integral unit.

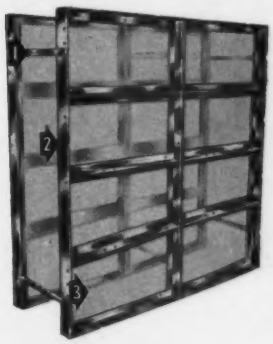


3. Next UNI-FORM Panel is placed in position. Tie Loop automatically enters square tie hole. Key is dropped in—assembly is complete. NO COMING BACK TO "FISH" TIES.

When you can tie and lock two concrete form panels in a few seconds, you're forming concrete fast! This is exactly what you can do with the UNI-FORM Panel System—the fastest system of forming concrete ever developed.

Faster tieing is only one of many UNI-FORM Panel features that makes them *the* pre-fab forms contractors are using on every kind of concrete construction. Write for the UNI-FORM Panel System Catalog and full details . . . or, call your nearby Universal Distributor or Branch Office for personal attention immediately.

UNI-FORM PANELS ERECT INTO A TIGHT, RIGID, AUTOMATICALLY ACCURATE CONCRETE FORM



1. Ties spread, lock UNI-FORMS into a form with automatically accurate wall thickness.
2. Steel frame provides structural strength and rigidity. Minimum alignment and bracing.
3. Best Exterior Grade Plywood face provides nailing surface. Easily turned for further reuses.

"Products from the Gold Tool Room"

UNIVERSAL FORM CLAMP CO. 1238 N. KOSTNER AVENUE • CHICAGO 51, ILLINOIS

BRANCH OFFICES and WAREHOUSES:
ATLANTA BALTIMORE CLEVELAND HOUSTON
LOS ANGELES SAN LEANDRO TORONTO

Circle 222 on reader service card

HOME BUILDER NETS

$4,675.32

EXTRA PROFITS USING SIMPLEX FORMS

Big Pay-off for 37 Basements

Contractor Norbert A. Paul, a builder in Billings, Montana, decided he could make more money by pouring his own home basements. Simplex proved his decision was right! With a standard set of Simplex 8-foot forms he poured 37 basements in one season and wound up with $4,675.32 in *extra profits*. He found Simplex Forms easy to handle . . . fast setting . . . easy to strip. And, Simplex gave him basement walls that were true and smooth. It's another example of success with Simplex. You, too, can go further ahead when you use "the world's fastest method of concrete forming."

Speedy Set-up and Stripping

NO LOOSE HARDWARE

- 1⅛" Plastic Impregnated Plywood with thick outer plys that will not peel. Forms have been used over 200 times and still pour a smooth wall.
- All hardware *firmly bolted* to panels. Exclusive locking levers and cam action draw panels tight . . . minimize seam marks and insure accuracy.
- Panels are light weight. Full 2' x 8' panel weighs approximately 67 lbs., completely fitted with backing bars and locking levers.

Send For Details

THE WORLD'S FASTEST METHOD OF CONCRETE FORMING

Simplex FOOT-A-MINUTE forms

Simplex Forms System, Inc.
5603 Industrial Ave., Rockford, Illinois

Circle 218 on reader service card

Design Criteria for Residential Slabs-on-Ground. Publication 657. *Published by National Academy of Sciences — National Research Council, 2101 Constitution Avenue, Washington 25, D. C. $2.00.*

This BRAB report to the Federal Housing Administration reports a tentative method of analysis for the selection and design of residential slabs-on-ground, which makes provision, in at least a qualitative manner, for the various factors which affect the satisfactory performance of residential slabs. The tentative design procedure involves a consideration of soil and climate conditions and, on the basis of these factors, the selection of one of the following slab types: unreinforced floating slabs, reinforced floating slabs, stiffened slabs and structural slabs. After the selection has been made, the critical dimensions and required reinforcing can be determined.

Practical Prestressed Concrete. *By H. Kent Preston, John A. Roebling's Sons Division, The Colorado Fuel and Iron Corporation. Published by McGraw-Hill, 327 West 41st Street, New York 36, New York. 335 pp. Illus. $11.50.*

This book furnishes simplified information on the design of safe, economical structures of prestressed concrete. Basic principles, design procedures and numerical examples are presented in terms of simple arithmetic and standard stress and moment formulas. All design examples are based on Tentative Recommendations for Prestressed Concrete prepared by an ACI-ASCE committee of experts.

The approach is practical, and several numerical design examples are carried through from beginning to end. In several of

Improved consolidation with PLASTIMENT

The new Guggenheim Museum . . . Frank Lloyd Wright's daring architectural achievement on New York's Fifth Avenue . . . testifies to the ability of Plastiment to provide sound, well-consolidated concrete under conditions of involved forming and complex reinforcing . . . Selected by the contractor, Plastiment Retarding Densifier was used to minimize cracking, to assure more uniform quality, and to provide architecturally pleasing exposed concrete over large areas . . . Plastiment gave the desired workability at 3 to 4 inch slumps, resulting in a minimum of surface defects when forms were stripped.

Call Sika direct or contact your nearest Sika distributor for catalog, technical information and service.

Dealers in principal cities, affiliates around the world.

Architect-Engineer: FRANK LLOYD WRIGHT / General Contractor: EUCLID CONTRACTING CORPORATION

The unique structure features a helical ramp making 6 turns at grades of 3% and stiffened by exterior webs at 30° intervals.

Sika®

SIKA CHEMICAL CORPORATION

Passaic, N. J.

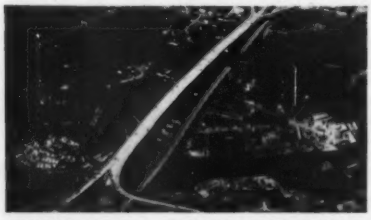
Circle 217 on reader service card

Easy, Proven Way to Permanently Bond New to Old Concrete —for less than 4¢ per square foot!

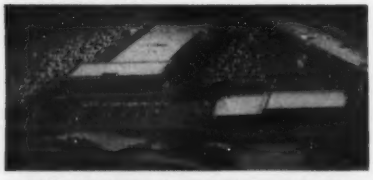
WELD-CRETE

Weld-Crete is the patented, job-proved liquid bonding agent which enables you to *permanently* bond new concrete, or cement plaster, *directly* to any other structurally sound surface no matter how smooth! No costly, time-consuming surface preparation. Just apply, let dry, and pour or trowel new concrete. Ideal for new construction, remodeling, repairs . . . *ramps, floors, precast shapes, driveways, highways, walls, machine mounts and pads.* Weld-Crete has equal bonding permanence all climates, all surfaces, all sorts of conditions. When used with quick setting cement topping you can lay new floors, ramps, driveways one day and run heavy truck traffic over them the next. Get fact-packed literature from your Building Materials Dealer, see Sweet's File, or write us direct. Address Larsen Products Corporation, P.O. Drawer 5938, Bethesda, Maryland.

Typical **WELD-CRETE** Applications



GRANVILLE ST. BRIDGE, VANCOUVER, BRITISH COLUMBIA—One of the largest 8 lane bridges in North America. Here Weld-Crete was applied to bridge surface to bond cement dividing strips. Now, over 4 years later, bonds are as good as new. *General Contractor:* Dominion Bridge Company.



SEVEN CORNERS SHOPPING CENTER, FALLS CHURCH, VIRGINIA—During construction of this 600,000 sq. ft. structure, initially only part of floor was poured and floated to a smooth finish. Areas in which show windows would be added were poured as base slab only. Slab was coated with Weld-Crete. After store fronts were custom-built, delayed toppings of 1" to 1½" thick were poured with assurance of permanent bond to base slab. These toppings were then finished with asphalt tile, wood, or finish flooring of lessee's choice. Designed and constructed by The Kass Realty Co. of the Kass-Berger Organization under direction of J. Franklin Groff. *Concrete Contractor:* Moses-Ekco.

Circle 212 on reader service card

the examples, inadequate members or tendons are chosen—common in actual design practice—and then the example proceeds to show how to correct the situation. At many points, too, the mathematical treatment is interrupted so that the economy of the section can be considered before the design proceeds too far. As an aid to the design of structures, construction methods and equipment are discussed, with special emphasis to prestressing tendons which are used in this country.

Among the topics included are properties of prestressed concrete, design procedures, materials, pre-tensioned and post-tensioned methods and when each should be used, and the design of typical members, girders, piles, and continuous structures. Handy tables and appendixes give information on properties of strands, wires, and bars, and specifications and recommendations for prestressed concrete design.

Concrete Pavement: Subbase and Joint Construction. Bulletin 229. *Published by Highway Research Board of the National Academy of Sciences—National Research Council, 2101 Constitution, Washington, D. C. 53 pp. $1.00.*

Three papers presented at the 38th annual meeting of the Highway Research Board are contained in this bulletin.

"Performance of Concrete Pavements as Related to Subbase Construction Methods," by Phil Fordyce and J. D. Geesaman, points out that uniformity of gradation was the one subbase quality found to have the most influence on pavement performance, with material of small maximum size generally performing better than coarser materials. Also, heavy construction traffic on the completed subbase nullifies the efforts expended to obtain uniformity and results in substandard pavement performance.

"Joint Construction in Concrete Pavement," by Gordon K. Ray, discusses the correct construction procedures for various types of joints, pointing out how incorrect practices result in substandard performance of finished pavements.

"A Theoretical Approach to Design of a Road Joint Seal" is the title of the third paper, presented by Egons Tons.

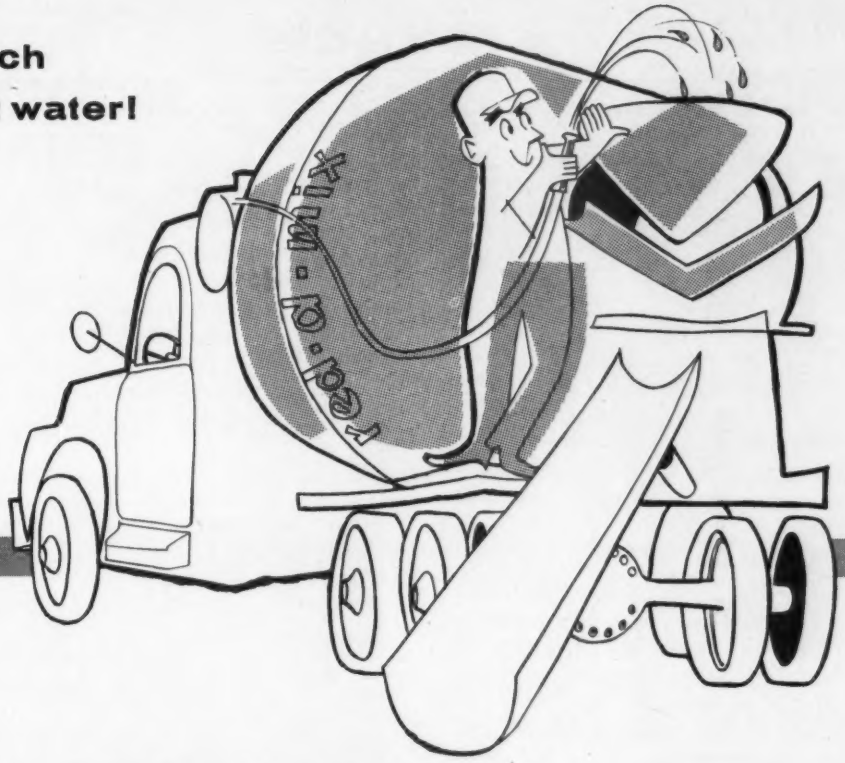
Recommended Practice for Placing Reinforcing Bars. *Prepared under the direction of the Engineering Practice Committee, Concrete Reinforcing Steel Institute, by R. C. Reese. Published by Concrete Reinforcing Steel Institute, 38 South Dearborn Street, Chicago 3, Illinois. 287 pp. $3.00.*

This manual was originally written as a guide for reinforcing bar setters. It became apparent that the manual would serve a much more useful purpose if expanded to cover the field of interest of the detailer who prepares the plans used by the bar setter, the engineer, architect, contractor and field inspector.

Increasing refinement of design methods and quality control of construction materials demands comparable improvement in construction practices. Without these improvements it would be very difficult, if not impossible, to utilize properly the progress being made in design concepts and materials.

Briefly, this manual summarizes the best of the accepted current practices in the placement of reinforcing bars, welded wire fabric, and their supports, in reinforced concrete structures.

watch
that water!

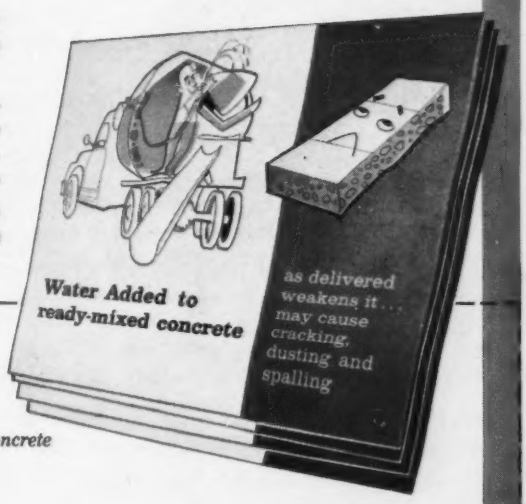


For quality concrete . . .
don't add extra water!

Ready-mixed concrete is designed for the job and delivered with all the water needed. Adding more can only cause trouble—cracking, spalling, dusting.

Reminding crews of this is important to your reputation for quality work. Do it easily by displaying the special poster (pictured at right) prepared by PCA.

It's one of a set of 4 posters reminding workers to safeguard quality by protecting concrete against heat, wind and freezing. A set is yours for the asking. (Free in U.S. and Canada only.) Just send the coupon.



FREE . . . SEND FOR YOUR POSTERS TODAY!

PORTLAND CEMENT ASSOCIATION

Dept. 2-98, 33 W. Grand Ave., Chicago 10, Illinois

A national organization to improve and extend the uses of concrete

Please send a free set of Quality Reminder posters.
I could also make use of ( ) additional sets.

COMPANY NAME_____

YOUR NAME_____

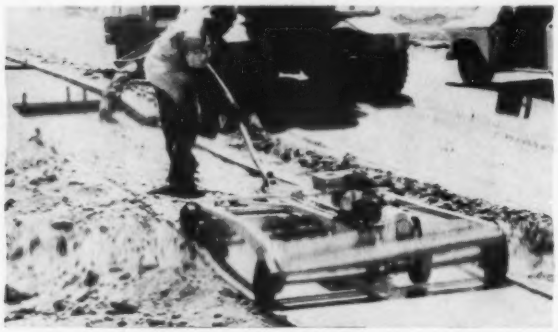
ADDRESS_____

CITY_____ STATE_____

Quality Reminder posters, 22" x17", 3 colors. Sets of 4 are free.

Circle 214 on reader service card

For additional information circle matching key number on reader service card on page 40A.



sidewalk lay-down machine **224**

This machine is designed to screed, tamp and float concrete sidewalks at a rate to 1,600 lineal feet per hour. Operation is automatic. One man handles concrete placement and another feeds concrete to machine. No special forming techniques are required. It operates on either steel or wooden forms, and stakes need not be level with forms. Jones Mfg. Co., P. O. Box 4311, Phoenix, Ariz.

forming accessory **225**

A workman prepares to strike a cast iron clip, known as a K-clip (see arrows) which supports a plywood form during construction of a dormitory at State Teachers College, Lock Haven, Pennsylvania. The clips are easily fractured, permitting the plywood forms to fall free. Clips are used here with lightweight structurals known as Junior Beams. Much of the cost saving on the project was attributed to the unusual flooring system. Jones & Laughlin Steel Corp., 3 Gateway Center, Pittsburgh 30, Penna.

SWIVEL ACTION HOLD-DOWN ANCHOR

Flexible control of cables during stressing operation.

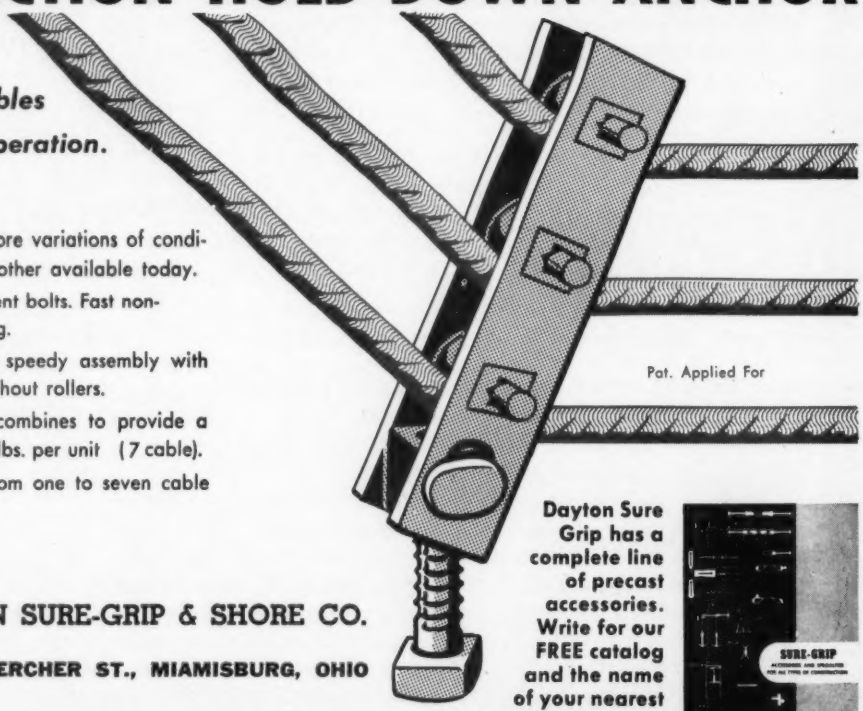
This ANCHOR will adapt to more variations of conditions during erection than any other available today.

Free-swivel action prevents bent bolts. Fast non-clogging threads speed stripping.

Press-on speed nuts provide speedy assembly with safety. Can be used with or without rollers.

Rugged hi-tensile ¾" bolt combines to provide a working load limit up to 16,000 lbs. per unit (7 cable).

Made to your needs with from one to seven cable strand construction.



Pat. Applied For

THE DAYTON SURE-GRIP & SHORE CO.

119 KERCHER ST., MIAMISBURG, OHIO

Dayton Sure Grip has a complete line of precast accessories. Write for our FREE catalog and the name of your nearest Sure Grip dealer

Circle 205 on reader service card

Why It PAYS TO USE EXPANSION JOINT FILLERS On EVERY Job

Every floor, driveway, sidewalk, apron or concrete slab you pour requires the same joint protection engineers provide when they specify premolded expansion joint fillers on their jobs. Drawings illustrate the effects of concrete expansion at unprotected and protected joints.

NO PROVISION FOR EXPANSION

ADEQUATE PROVISION FOR EXPANSION

Adequate use of premolded expansion joint filler can be considered as a "safety valve" for expanding concrete. Unless it is provided, the compressive stresses set up lead to cracking and spalling of the slab ends, general deterioration of the concrete—all of which add up to trouble for the contractor. Why take the risk, when premolded expansion joint costs so little?

Failure to provide the protection given by adequate expansion joints and joint fillers can cause expensive problems. Expansion joint fillers like Servicised Asphalt or KORK-PAK help guarantee you against expensive call-backs and dissatisfied customers.

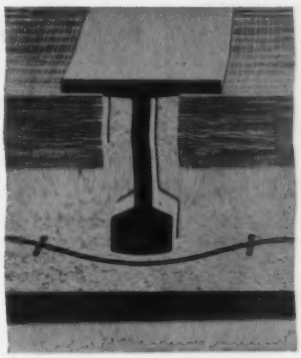
Should you have any difficulty locating a source of supply for Servicised Expansion Joints, write for the name of your nearest Distributor.

SERVICISED PRODUCTS CORPORATION
6051 West 65th Street • Chicago 38, Illinois

Circle 216 on reader service card

products

For additional information circle matching key number on reader service card on page 40A.



form board 226

Drawing shows installation of glass cloth faced form board in combination with steel-reinforced, poured-in-place roof deck, covered with Perma-Ply built-up roofing. According to the manufacturer this product offers outstanding thermal and acoustical qualities, fire safety, durability, and ease of handling and installation. It is recommended for low ceiling areas, gymnasiums, and multi-purpose rooms open to ceiling damage. Owens-Corning Fiberglas Corp., 717 Fifth Ave., New York 22, N. Y.

forming catalogue 227

A form catalogue presents developments designed to minimize the time spent in stripping, cleaning and resetting forms. A form handling frame that will strip or re-position side forms in one operation and a form lock which uses the natural flexing ability of metal to strip forms from concrete are included. Food Machinery and Chemical Corporation, Form-Crete Dept., P. O. Box 1718, Lakeland, Fla.

here's how TRETOL's "ACTIONATE" can ease your Winter Concreting problems and save you money...

ACTIONATE

- Speeds up the initial concrete set time
- Permits finishers to finish faster, without delay, for sharply reduced labor costs
- Permits a substantial reduction in the water/cement ratio
- Provides greater workability and ease in placing
- Eliminates or minimizes the need for artificial heat or coverings
- Extends the concreting season—permits jobs to be completed on schedule

FOR FASTER, BELOW FREEZING CONCRETING

ACTIONATE is a multi-purpose liquid chemical admixture that is added directly to the gaging water of the concrete mix where it speeds up the concrete hydration and curing, and permits concrete placing in sub-freezing conditions. ACTIONATE's formulation contains Tretol's superior wetting agent that imparts a greater wetting action to the water, thus reducing the amount of water normally required to attain a given slump and workability.

LET "ACTIONATE" GO TO WORK FOR YOU THIS WINTER!

For more detailed information and the name of your nearest Distributor write

TRETOL INC.
Quality Products for Concrete and Masonry
7252 W. 66th STREET, CHICAGO 38, ILLINOIS

Circle 221 on reader service card

Circle 202 on reader service card

for money-saving forming ideas

get this free book of REX® Steel Forms

Modern forming methods can save you time, trouble and money! This big 30-page catalog tells and shows how you can profit from "assembly-line" forming. It covers all kinds —Rex Curb, Curb and Gutter, Sidewalk—with features...check list of types...pictures and descriptions...information on infinite setups. Also, flexible forms, road and airport forms. This is "must" business reading for concrete contractors.

GET YOURS NOW!
See your Rex Distributor or write CHAIN Belt Company, 4671 West Greenfield Avenue, Milwaukee 1, Wisconsin. In Canada, CHAIN Belt (Canada) Ltd., 1181 Sheppard Ave. East, Toronto.

Write for Bulletin 57-16.

REX®
CONSTRUCTION MACHINERY

For good workability at low slumps . . . use

HORN

SYMENTARD

Whenever job requirements call for concrete mixes that have to have good workability at low slumps—use Horn's Symentard—the concrete retarding densifier.

Since Symentard works by slowing down the rate of hydration, and not by entraining air, the proportions can be varied to meet job and climatic conditions. This means stronger, denser concrete that will have higher resistance to cracking.

For complete details and technical data, call or write:

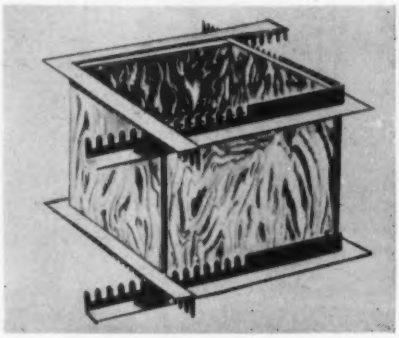
A. C. Horn Companies
Subsidiaries & Divisions
Sun Chemical Corporation
750 THIRD AVENUE • NEW YORK 17, N. Y.

Plants in Long Island City • Chicago • Houston • Los Angeles • San Francisco • Portland, Ore. • Toronto • North Bergen, N. J. • Sales Offices and Warehouses throughout the United States and Canada.

Circle 211 on reader service card

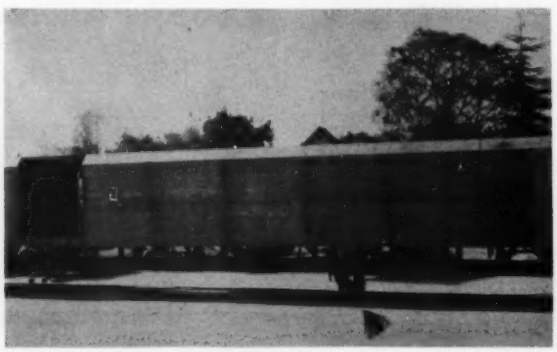
products

For additional information circle matching key number on reader service card on page 40A.



square column form clamps 228

A hammer is the only tool needed to set these steel form clamps for square or rectangular concrete columns. Notches on 1-inch centers eliminate measuring. The 24-inch clamps form 9- by 9-inch through 24- by 24-inch columns, and the 36-inch clamps form 11- by 11-inch through 36- by 36-inch columns, or any combination of dimensions within these sizes in 1-inch increments. Other sizes are available to order. Deslauriers Column Mould Company, 5036 West Lake Street, Chicago, Ill.

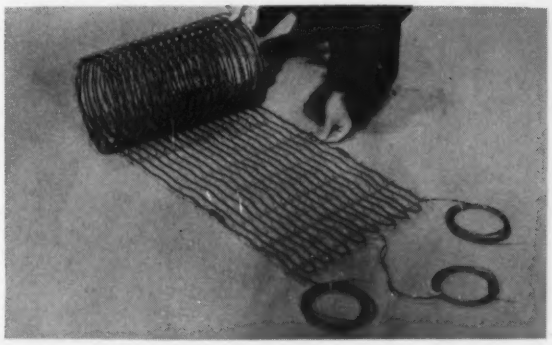


storm drain forms on casters 229

Casters (see arrow) which can support loads up to 15,000 pounds per caster support these 52-foot long, 8½-ton portable steel forms for storm drains. After floor slab has hardened in trench, forms are lowered into excavation and positioned, and reinforcing is placed. Concrete is then placed around forms. When concrete has reached sufficient strength, hinged sides of forms are broken away and swung inward, jacks are lowered, and the device, now resting on the casters, is pulled forward on the floor slab and positioned for next pour. Faultless Caster Corporation, Evansville, Ind.

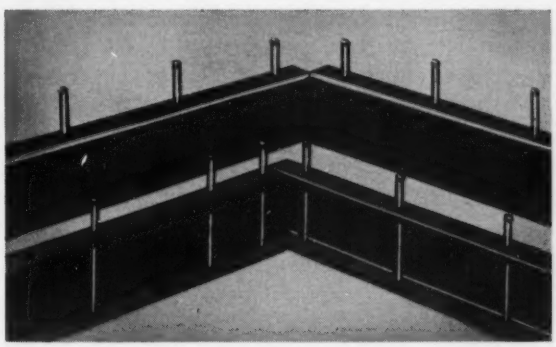
products

For additional information circle matching key number on reader service card on page 40A.



electric snow melter **230**

Snow shoveling is eliminated by a low-temperature radiant heating system beneath concrete walks and driveways. Pre-spaced thermoplastic insulated resistance wire is anchored in place in galvanized steel mesh mats 10 feet long and 18 inches wide. Non-heating lead wires and ground lead are attached. Preassembled units are rolled into place, saving installation time. Wire mesh also protects the heater wire and adds extra reinforcement to concrete. Wires will not float together to cause burn-outs as concrete is placed. According to the manufacturer, uniformly even heat is assured and simple installation makes a lower selling price possible. Easy-Heat, Inc., Lakeville, Ind.



footer forms **231**

Lightweight metal forms which are easy to set up are supported by ½-inch reinforcing rods, driven through holes in flanges. They can be bent into curves by snipping the flanges between the holes. Said to be more economical than wood, the footer forms do not rot or split and are easily cleaned for re-use. Forms are recommended for concreting walks, driveways and patios. They are available in 10-foot lengths, 4, 6 or 8 inches high. Quaker State Metals Co., Lancaster, Pa.

ROCFORM
Adapt-A-Clamp system
touches all the BASES!

INSTITUTIONAL
COMMERCIAL
INDUSTRIAL
RESIDENTIAL

CONCRETE WALL FORMING

Never before has there been a concrete form hardware system that is so practical . . . so simple. And because of its simplicity, concrete and general contractors on all types of wall work can convert their existing forms AND PAY FOR ADAPT-A-CLAMPS with:

FASTER SET-UP TIME
FASTER STRIPPING TIME
LONGER FORM LIFE
CLEAN, TRUE NO-SEAM WALLS

See the ROCFORM ADAPT-A-CLAMP system in action at the NATIONAL READY-MIX CONCRETE ASSOCIATION CONVENTION in Chicago, February 15-18, Hilton Hotel, Booth #9.

READY-MIX MEN!

There are plus profits in form rentals. Rocform has the plan . . . check on it at the convention or write today.

ONLY ROCFORM OFFERS:
Complete wall forming systems, conversion hardware for your present panels backed by on-the-job technical assistance, an iron-clad guarantee of satisfaction.
Get full details on financial planning that really counts!
LEASE-PURCHASE
OUTRIGHT PURCHASE

ROCFORM CORPORATION
15160 W. EIGHT MILE ROAD • DETROIT 35, MICH.

Circle 215 on reader service card

Circle 204 on reader service card

NON-SLIP CONCRETE

INSTALL NON-SLIP AND EXTREMELY WEAR RESISTANT SIDEWALKS AND SURFACES BY APPLYING HARD ABRASIVE GRAINS

Two Grades

SPARKLING NON-SLIP
SILICON CARBIDE 12/30

REGULAR NON-SLIP
ALUMINUM OXIDE 14/36

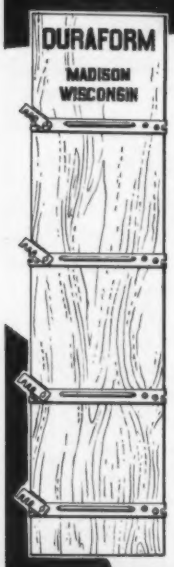
Many Uses

SWIMMING POOLS ★ SIDEWALKS
WAREHOUSES ★ SCHOOL GROUNDS
RAMPS ★ STAIRWAYS ★ ETC.

FRANK D. DAVIS CO.
3285 E. 26TH ST. • LOS ANGELES 23, CALIF. • ANgelus 9-7311

Eastern Office | NIXON, NEW JERSEY • Charter 9-8191

DURAFORM



The plastic impregnated plywood forms with "BUILT IN" SPEED for MORE PROFITS

★ One man can set a Duraform panel.
★ No loose hardware to handle or lose.
★ All panels are reversible for outside or inside walls.
★ Duraforms combine framing and bracing in one unit.

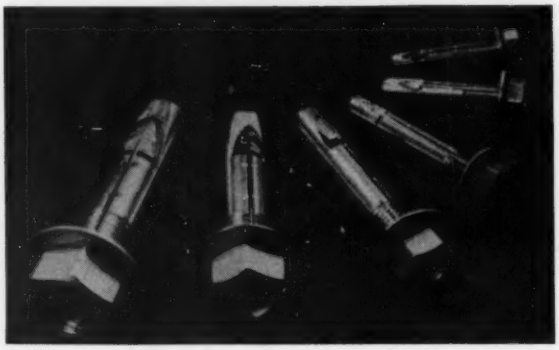
For larger profits next season write today for complete information.

DURAFORM, INC.
2903 W. Beltline Hwy., Madison Wisconsin

Circle 209 on reader service card

products

For additional information circle matching key number on reader service card on page 40A.



expansion bolt 232

Designed to simplify the fastening of electrical equipment, structural members, machinery, etc., in concrete, masonry, plastic, stone, steel and other non-frangible materials, a one-piece, single integral expansion bolt eliminates the need for marking operations, requires only one size hole and expands as it is wrench-tightened to provide a lasting anchor, according to the manufacturer. Kirel, Inc., Kingston, N. Y.

epoxy resins 233

A 6-page technical bulletin, SEC 759, describes the background and use of epoxy resins for bonding, patching, joint and crack sealants, surface coatings for concrete, and for resurfacing of pavements. Six epoxy compounds are specifically designed for particular construction applications and make possible many construction techniques and repairs previously considered difficult or impractical. These compounds offer the contractor, engineer and architect a new tool for building and heavy construction projects. Sika Chemical Corporation, 35 Gregory Avenue, Passaic, N. J.

automated form coating 234

Production coating of steel forms with a form release agent is saving time and cutting costs on a thruway project in California. Form compound is a water-emulsion material which permits quick stripping of concrete members without sticking. Belt conveyor carries forms through machine in contact with a saturated felt roller which coats the surfaces with an even layer of the solution. Pits, holes and stains are said to be eliminated from concrete after stripping. Shell Oil Co., 50 W. 50th St., New York 20, N. Y.

products

For additional information circle matching key number on reader service card on page 40A.

grid system 235

The Grid system of reinforced concrete construction is fully described in a new 4-page folder. This system, utilizing steel Grid domes in 2-foot modules, is said to speed building time and save material and labor costs over comparable-strength flat slab construction. Concise, clearly illustrated descriptions of the Grid System, steel Grid domes, formwork and utility layouts, as well as comprehensive typical safe load tables and typical layouts of ceilings and floors utilizing the Grid system construction are presented. All who work with concrete will find this folder an interesting and informative reference guide to efficient, economical concrete construction. Grid Flat Slab Corp., 761 Dudley St., Boston 25, Mass.

manual of materials 236

An extensive line of products for use in concrete construction and maintenance are described in a manual. The products are classified in 3 categories: concrete surface treatments, concrete integral mixtures, and waterproofing and dampproofing. These materials are said to offer the user many outstanding advantages and features. A product information guide gives the function of each of the 27 materials and an estimating guide tells amounts required and application methods. Tretol, Inc., 6531 West 63rd Street, Chicago, Ill.

forming 237

"How to Sell a Form" is a humorous sketch of more than 50 years experience in the concrete form and hardware industry. How salesmen help the contractor solve forming problems is explained. Symons Clamp & Manufacturing Company, 4249 West Diversey Avenue, Chicago, Ill.

drilling equipment 238

A 12-page bulletin describes a line of horizontal, vertical, and angular drilling and boring equipment, and discusses the wide variety of air, hydraulic, electric, and gasoline powered drills available. On-the-job photos show equipment working in clay, sand, gumbo, frozen ground, shale and limerock. Tables give specifications and other information. Kwik Mix Co., 235 West Grand Ave., Port Washington, Wisc.

SYMONS Steel Stake

Can Be Reused Indefinitely

Drives easily into hard earth. Can be used for practically any type of stake work. This popular item is available in 12", 18", 24", 30", 36" and 42" sizes.

Pullout hole for easy removal
Easily secured to lumber—can be nailed every 1" O.C.
"I" beam design drives easier, holds best
Hi-Carbon Alloy Steel tough to bend
Rugged point with minimum deflection

Symons

SYMONS CLAMP & MFG. CO.
4271 Diversey Ave., Chicago 39, Ill., Dept. B-0

We will send contractors a sample 12", 18" or 24" stake if request is received on company letterhead. Please include 50c for 12", 75c for 18", $1.00 for 24" to cover cost of postage and mailing.

Name_____
Firm_____
Address_____
City_____ Zone____ State_____

Circle 220 on reader service card

AVAILABLE NOW TO READERS OF CONCRETE CONSTRUCTION

Annual editions of back issues—all 12 months in one hard-covered volume (covered in handsome maroon buckram cloth) to serve as your permanent reference file on day-to-day concreting problems.

So valuable and handsome is this volume that we will stamp your name in gold on the front cover to assure its return to your desk or bookshelf when others borrow it.

It's PERMANENT
It's PERSONALIZED

$10.00 per volume

Limited supply only of 1958 and 1959 volumes

PAYMENT MUST ACCOMPANY ORDER.

☐ 1958 ☐ 1959

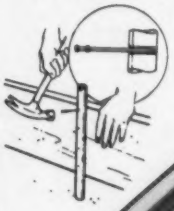
Your Name_____
Firm_____
Street Address_____
City_____ Zone_____
State_____

Circle 206 on reader service card

STEEL STAKES by *dee*

STOP this WASTE

HERE'S HOW



100 or more uses
Set up 10 times faster
Strip 20 times faster

HOLDS SOLIDLY
DRIVES RAPIDLY . . .
regardless of rotation or subgrade

dee Concrete Accessories Co.
Phone: MOhawk 4-3664
670 N. Michigan Ave., Chicago 11, ILL.

Index to Advertisers

Allied Chemical Corp., Solvay Process Div.	42
Chain Belt Co.	52
Concrete Transport Mixer Co.	inside front cover
Frank D. Davis Co.	54
Dayton Sure-Grip & Shore Co.	50
Dee Concrete Accessories Co.	56
Dewey and Almy Chemical Div.	41
F. W. Dodge Corp.	39
Duraform, Inc.	54
Economy Forms Corp.	inside back cover
A. C. Horn Companies	52
Larsen Products Corp.	48
Patent Scaffolding Co.	40
Portland Cement Association	49
Rocform Corp.	53
Servicised Products Corp.	51
Sika Chemical Corp.	47
Simplex Forms System	46
Symons Clamp & Mfg. Co.	43 and 55
Tretol, Inc.	51
Universal Form Clamp Co.	45
Viber Co.	44

products

For additional information circle matching key number on reader service card on page 40A.

hold-down anchor 239

A non-rigid hold-down anchor is said to simplify assembly and stripping in prestressed concrete. The anchor swivels in the direction from which cable tension is exerted, thus easing pull on the bolt which holds the anchor in position. This positive action aids in preventing bent bolts and makes more flexible control of cables possible during stressing operations, according to the manufacturer. Speed nuts permit faster assembly and coil threads are non-clogging for faster stripping. Dayton Sure-Grip and Shore Company, Miamisburg, Ohio.

retardant 240

Retardation of initial set in concrete is the subject of two bulletins. "Retarders and Plastic Concrete" is the title of bulletin 438-7, and "Retardation of Initial Set: Effect on Hardened Concrete" is the title of bulletin 438-8. Dewey and Almy Chemical Division, W. R. Grace & Co., Cambridge, Mass.

bonding agent 241

A material for bonding new concrete to old or to other materials permits resurfacing of marred concrete surfaces with a new layer of concrete without roughing the old surface. The folder also describes a silicone water repellent for masonry and a latex resurfacing compound. The firm also manufactures a concrete surface hardener and masonry cleaning compounds. Garfield Concrete Chemical Co., 7515 Grand Division, Cleveland 25, Ohio.

V

S

B

6

XU